Quantifying precipitation and actual evapotranspiration from precision lysimeter data

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Introduction

Weighing lysimeters allow the precise quantification of precipitation (P) and actual evapotranspiration (ET). While the calculation of P and ET is straightforward in theory, the processing of real-life data is error-prone because of:

• data gaps
• noise caused by wind
• outliers caused by objects on the lysimeter
• offset in mass after sampling of leachate
• temperature effects on the scale
• biomass growth and removal by harvesting

Proposed Method

I. Reconstruction of the upper boundary flux: Temporal differences of lysimeter mass and cumulative outflow are calculated as backward finite differences (Fig. 2b and 2d). Rates outside a-priori defined, physically plausible ranges are either set to zero (drainage) or discarded (lysimeter mass).

II. Smoothing of time-series: We tested various smoothing techniques to filter noise. Currently, we favour a 2nd-order Savitzky-Golay filter with a moving window of length 1 hour (Fig. 3a).

III. Calculation of the mass balance: Positive changes greater than a time-dependent threshold are treated as precipitation. Correspondingly, negative changes are interpreted as actual evapotranspiration (Fig. 3b). Threshold values are obtained using a scaled moving median through the absolute residuals of smoothed and measured data.

Performance was assessed using synthetic and real data.

Conclusions

• Relative errors for cumulative P and ET were less than 0.3 % after a period of 90 days (synthetic data).
• Selection of filter thresholds and smoothing parameters is non-trivial.
• Visual inspection of data and results is still necessary.
• Gap-filling remains a challenge; linear interpolation will always lead to an underestimation of fluxes.

Open Questions

• Can we automatically determine smoothing parameters (e.g. by means of cross-validation) to reduce the number of input parameters?
• Can we set physically plausible values for both significant changes in mass and the outlier algorithm?
• How can we handle missing data? What are the alternatives to gap-filling with the help of external data sources?
• Is it possible to validate the approach?

Acknowledgements

We thank the „Arbeitskreis Lysimeterdatenauswertung“ for an active exchange of ideas. The presented data sets were kindly provided by the TERENO network and JOANNEUM RESEARCH.